

UNITED STATES DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION CROP ROTATION (ACRE)

CODE 328

MONTANA TECHNICAL GUIDE

SECTION IV

DEFINITION

Growing crops in a recurring sequence on the same field.

PURPOSES

This practice may be applied as part of a conservation management system to support one or more of the following:

- Reduce sheet and rill erosion.
- Reduce irrigation induced erosion.
- Reduce soil erosion from wind.
- Maintain or improve soil organic matter content.
- Manage deficient or excess plant nutrients.
- Improve water use efficiency.
- Manage saline seeps.
- Manage plant pests (weeds, insects, diseases).
- Provide food for domestic livestock.
- Provide food and cover for wildlife.
- *Reduce toxic salts.*
- *Improve soil quality/health.*

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland and other land where crops are grown.

This standard does not apply to pastureland, hayland, or other land uses where annual row or close growing crops are grown occasionally only to facilitate renovation or re-establishment of perennial vegetation. It does not apply to land devoted to orchards, vineyards, or nurseries.

CRITERIA

General Criteria Applicable To All Purposes Named Above

Crops shall be grown in a planned, recurring sequence except as outlined in Operation and Maintenance.

Crops shall be adapted to the climatic region and the soil resource. Adapted crops and varieties, listed in *Montana State University Cooperative Extension, or other* appropriate university publications or other approved sources, shall be selected.

A conservation crop rotation may include crops planted for cover, *pest control*, or nutrient enhancement.

As a minimum, develop a conservation plan which, alone or in combination with other conservation practices:

1. Will reduce soil erosion from both wind and water to within the soil loss tolerance using currently approved erosion prediction technology.

2. Will utilize excess plant nutrients to levels non-threatening to water, plant, and animal resources.

When grass or legume species are included in the crop rotation, conservation practice standards for FOTG, Section IV, Pasture and Hayland Planting (512), and/or Forage Harvest Management (511) will be used.

If a crop or forage is planned in the rotation for cover or green manure

NOTE: This type pf font ((**AbBbCcDdEe 123..**)) indicates NRCS National Standards.

*This type of font (**AaBbCcDdEe 123..**) indicates Montana Supplement.*

purposes, the standards for FOTG, Section IV, Cover and Green Manure Crop (340) will be used.

One of the following, or other as approved by the state agronomist, conservation crop rotations will be designed:

A. Annual Cropping Rotation—This rotation applies where; 1) irrigation water is available, or 2) when the probability of receiving growing season precipitation plus stored plant available moisture is 9 or more inches for 7 out of 10 years.

B. Flexible Crop Rotation—This is a modified crop-fallow rotation where the decision to recrop or fallow is based on the amount of stored soil moisture and rainfall probabilities. Fallow may include chemical application or mechanical tillage. Flexible cropping is generally designed to use available subsoil moisture in soils 5 feet deep or less.

The two major factors in deciding to crop or not to crop in a flexible crop rotation are the annual available water and the stored subsoil moisture available just prior to planting. Approximately 9 inches of available water is needed to produce, at a minimum, an economic small grain crop. Available water is stored soil moisture plus the potential growing season precipitation expected at the 70 percent probability level. The upper 4 feet of soil is used to calculate the stored soil moisture. It should be noted that this method assumes adequate weed control and adequate fertility levels to meet production goals.

C. Flexible Legume-Cereal Rotation—In this rotation a legume crop is seeded in lieu of fallow in the standard dryland crop-fallow or flexible crop rotation for purposes of building soil quality, soil fertility, organic matter, weed control, or providing forage. The legume is seeded as early as possible, and then the management of the legume is flexible,

dependent on growing season precipitation. In a dry year the legume is terminated as green manure. If good moisture prevails, the crop can be maintained for forage or seed production. In this rotation, subsoil moisture must be monitored regularly and the crop terminated before excess subsoil moisture is extracted. As a general rule, the legume should be terminated when subsoil moisture is depleted down to 3-4 inches.

DETERMINING PLANT AVAILABLE SOIL MOISTURE

Follow these steps to determine plant available soil moisture and to decide whether or not to recrop:

- 1. Determine the soil texture in the upper 4 feet of the soil profile by field inspection or from a soil survey.*
- 2. Determine the average depth of stored soil moisture as close to planting as possible using the soil probe or auger. Convert the depth of soil moisture to plant available moisture using Table 1.*

a) Spring Planting Decisions for Flexible Cropping. If the available soil moisture plus the estimated growing season precipitation based on the 70% probability level in Table 2 is less than 9 inches, do not plant a small grain crop. If available water is 9 inches or more, plant a spring small grain crop (the decision process is the same for non small grain crops except that water requirements are different.

b) Fall Planting Decisions for Flexible Cropping. Plant a winter wheat crop when there is 1 inch or more of plant available soil moisture in the top foot of soil and the average winter-stored soil moisture plus growing season precipitation is equal to 8 inches or more.

For winter wheat, growing season precipitation is assumed to equal average precipitation from fall seeding until June 30 with the following adjustments:

1) Under fallow conditions, when the soil profile is at field capacity (4-feet), no additional moisture credit is given for precipitation received from time of planting to April 1.

2) Under clean-tilled fallow conditions, with the soil profile is at less than field capacity to a 4-foot depth, 12 percent of the average precipitation from date of planting to April 1 is assumed.

3) Thirty-three (33%) credit is given for winter precipitation when there is standing stubble and 25 percent for worked stubble.

4) Use 48% credit for a herbaceous barrier system.

c) Planting Decisions for Summer Fallowed Land for Flexible Crop Rotation. Plant a crop on summer fallow fields regardless of stored soil moisture. Tilled double summer fallow is not recommended due to potential for erosion and salinity problems.

d) Planting Decisions for Flexible Legume-Cereal Rotation. Plant a legume crop as early as possible when it is determined available water makes a small grain (or other) crop unfeasible.

PRECIPITATION PROBABILITIES

Table 2 shows the probability (%) of receiving at least the indicated amounts of growing season precipitation for three different time periods during the growing season at 24 locations in Montana. Look up the precipitation in inches using a probability equal to 70 percent. For locations not covered in Table 2, use the Precipitation Probability Map, Figure 1.

Additional Criteria To Reduce Sheet And Rill Erosion

Crops shall be selected that produce enough above and below ground plant biomass, *and at the proper time*, to control erosion within the soil loss tolerance (T) or any other planned soil loss objective.

The amount of biomass needed shall be determined using current approved erosion prediction technology, RUSLE (*revised universal soil loss equation, FOTG IV, Section I, Erosion Prediction*).

Calculations shall account for the effects of other practices in the conservation management system.

Additional Criteria To Reduce Irrigation Induced Erosion

To reduce erosion induced by furrow irrigation, crops or cover crops, *in combination with additional cultural or managerial practices*, shall be selected that are grown within the wetted perimeter of the furrow, or which produce the amount of residue needed to be maintained in the furrow to achieve the soil loss objective. The amount of residue needed shall be determined by approved research.

To reduce erosion induced by sprinkler irrigation, crops or cover crops shall be selected that develop surface cover or canopy rapidly, or that produce the amount of residue needed to be maintained on the soil surface to achieve the soil loss objective. The amount of residue needed shall be determined by approved research.

Where erosion induced by sprinkler irrigation is a concern, additional practices and management may be required to meet resource objectives including irrigation water management, tillage practices, contour stripcropping, contour farming, and basin tillage (dammer-diker). Basin tillage should not be performed on slopes greater than three (3) percent.

Additional Criteria To Reduce Soil Erosion From Wind

Crops shall be selected that produce biomass in amounts adequate, and at the appropriate time, to control erosion to within the soil loss tolerance (T) or other planned soil loss objective.

The amount of biomass needed shall be determined using current approved wind erosion prediction technology. Calculations shall account for the effects of other practices in the conservation management system.

Additional Criteria To Maintain Or Improve Soil Organic Matter Content And Overall Soil Quality/Soil Health

Crops shall be selected that produce the amount of plant biomass needed to maintain *or improve* soil organic matter content.

If partial removal of residue by means such as baling or grazing occurs, enough residue shall be maintained to achieve the desired soil organic matter content goal.

Cover and green manure crops planted specifically for soil improvement may be grazed, as long as grazing is managed to retain adequate biomass.

Burning of crop residues are limited to one (1) burn every seven years.

Appropriate crops and their management shall be selected that maintain or improve soil quality. Soils have chemical, biological, and physical properties that interact in a complex way to give soil its quality or capability to function. Thus, soil quality cannot be measured directly, but must be inferred from measuring changes in attributes or attributes of the ecosystem (indicators). Table 3 shows soil quality indicators and their relationship to soil condition and function.

To assess soil quality, a baseline data set must be gathered using an approved soil health tool kit, Montana soil health score

cards, or other tools (as approved by the state agronomist). Subsequent data collections must be gathered and documented monthly during the growing season for several years to provide an indication as to the trends of soil quality/soil health.

Additional Criteria To Manage Deficient Or Excess Plant Nutrients

Crop selection and sequence shall be determined using an approved nutrient balance procedure. *Use the Nutrient Management Worksheet, MT-JS-ECS-127, found in the FOTG, Section IV, Nutrient Management (590) to document plant nutrient balance.*

When crop rotations are designed to add nitrogen to the system, nitrogen-fixing crops shall be grown immediately prior to or interplanted with nitrogen-depleting crops.

To reduce excess nutrients, crops or cover crops having rooting depths and nutrient requirements that utilize the excess nutrients shall be grown.

Where excess nutrients or soil contaminants are a concern, rotating deep-rooted crops, cover crops, or forages, with shallow-rooted crops can assist in recovering nutrients or contaminants from the soil profile.

Where soil characteristics and climatic conditions are such that non-point source pollution may be caused by nutrients in runoff water, measures should be implemented to eliminate runoff including filter strips, contour farming, contour strip cropping, residue management, and conservation tillage.

Additional Criteria To Improve Water Use Efficiency

Selection of crops and varieties, sequence of crops, or the annual decision to plant a crop or to fallow, shall be determined using an approved water balance procedure. ***See Flex Cropping procedures under considerations.***

Additional Criteria To Manage Saline Seeps

Crops grown in the recharge area of saline seeps shall be selected for rooting depths and water requirements adequate to fully utilize all plant available soil water. Summer fallow will not be used. Crop selection and sequence shall be determined using an approved water balance procedure.

If excess subsoil moisture exists below the rooting depth of crops commonly grown in the recharge area, deep-rooted perennial crops shall be established for the number of years needed to dry the soil profile.

Crops grown in the discharge area of saline seeps shall be selected for their tolerance to salinity levels in the discharge area.

See FOTG, Section IV, Salinity Management (571).

Additional Criteria To Manage Plant Pests (Weeds, Insects, Diseases)

When this practice is implemented, for the primary purpose of managing plant pests, crops shall be alternated to break the pest cycle and/or allow for the use of a variety of other control methods. Affected crops and alternate host crops shall be removed from the rotation for the period of time needed to break the life cycle of the targeted pest.

Resistant varieties, listed in appropriate *Montana State University Extension* publications or other approved sources, shall be selected where there is a history of a pest problem.

Additional Criteria To Provide Food For Domestic Livestock

When this practice is selected for purposes of providing food for livestock, crops shall be selected to balance the feed supply with livestock numbers. The needed amount of selected crops shall be determined using an approved forage-livestock balance procedure. *Montana approved forms and procedures include (but are not limited to) CPA-18B Feed Forage and Livestock*

Balance Worksheet, GLA, and exhibits in the Range Handbook.

Additional Criteria To Provide Food And Cover For Wildlife

When this practice is selected for purposes of providing food and cover for wildlife, crop selection shall be determined using the approved habitat evaluation procedure, found in the *Montana Wildlife Habitat Appraisal Guides*.

CONSIDERATIONS

Crop Rotation - growing a sequence of crops rather than always the same crop in the same field, is probably the most critical factor affecting the health and productivity of a future crop. Production yields are determined as much by what was grown (or not grown) in the same field the previous two or three years as by the management of the current crop.

When used in combination with CROSS WIND STRIPCROPPING (589B) or STRIPCROPPING CONTOUR (585), the crop sequence should be consistent with the strip cropping design.

When used in combination with RESIDUE MANAGEMENT practices, selection of high residue producing crops and varieties, use of cover crops, and adjustment of plant population and row spacing can enhance production of the kind, amount, and distribution of residue needed.

Where erosion induced by furrow irrigation is a concern, irrigating only alternate furrows may reduce the erosion hazard and provide better soil aeration.

Where erosion induced by sprinkler irrigation is a concern, the hazard can be reduced by basin tillage (dammer-diker), contour farming, or contour strip cropping.

Where erosion induced by furrow irrigation is a concern, the use of soil conditioners such as PAM (polyacrylamide) may increase water infiltration and reduce irrigation induced erosion.

Where maintaining or improving soil organic matter content is an objective, the effects of this practice can be enhanced by managing crop residues,

utilizing animal wastes, or applying mulches to supplement the biomass produced by crops in the rotation.

Where rapid residue decomposition is desirable, residue should be incorporated into the soil before the six (6) inch mid-day soil temperatures drop below 55-60 degrees fahrenheit in the fall. If irrigation water is available, maintaining adequate soil moisture (at or above 50% available water holding capacity) increases microbial activity and residue decomposition.

Where excess plant nutrients or soil contaminants are a concern, rotating deep rooted crops or cover crops with shallow rooted crops can help recover the nutrient or contaminant from the soil profile.

Where precipitation is limited, seasonal or erratic, moisture can be conserved for crop use by maintaining crop residues on the soil surface to increase infiltration and to reduce runoff and evaporation. Where winter precipitation occurs as snow, additional moisture can be obtained for crop use by trapping snow with standing residue, windbreaks, or other barriers. *To be most effective in trapping snow, crop residues should be cut in a scalloped pattern (i.e., one header width of residue is cut at 12 inches, the next is cut at 8 inches, the next is cut at 18 inches, etc.)*

Where improving water use efficiency on deep soils is a concern, rotating deep rooted crops with shallow rooted crops can help utilize all available water in the soil profile.

Crop damage by wind erosion can be reduced by this practice by selecting crops which are tolerant to abrasion from wind blown soil or tolerant to high wind velocity. If crops sensitive to wind erosion damage are grown, the potential for plant damage can be reduced by crop residue management, field windbreaks, herbaceous wind barriers, intercropping, or other methods of wind erosion control.

Soil compaction can be reduced by this practice when rotations including deep rooted crops (able to extend to and penetrate the compacted soil layers) are used in combination with deep tillage, controlled traffic, or management of grazing animals to prevent, or breakup, compacted layers.

Deep-rooted crops, such as alfalfa, safflower, or sunflowers, can be used to prevent saline seep or accelerate the reclamation of land affected by it. Saline seeps are exacerbated by clean tilled summer fallowing and is best managed by growing crops, cover crops, or forages, to use soil water.

Salt tolerance of crops/forages varies considerably among species, but is also dependent on cultural conditions. Yield response relations show that crops tolerate salts up to a threshold level. Salts that exceed these threshold levels result in linear yield decreases as salts increase.

Irrigation water should be tested for salt contents. As salt content of irrigation water increases, greater care must be taken to plant salt tolerant crops and forages.

Fallow is primarily used for two reasons, to control pests and to enhance soil moisture. Fallow allows for concentrated control of some pests not always possible when growing a crop (tillage and/or herbicide application). However, intensive tillage may cause excess erosion degrading the soil resource. Fallow, especially clean-tilled fallow, may also accelerate salinity problems by not utilizing excess soil moisture.

A field may be cropped every year in a rotation where the soil profile is recharged sufficiently with available water to grow the next crop. Different crops extract water from different depths. For example, buckwheat and peas seldom remove water deeper than 3-4 feet. Whereas, winter wheat extracts water to about 6 feet. Spring wheat and barley extract water deeper than peas but less than winter wheat.

Proper crop rotation will reduce populations of soil- and residue-inhabiting pests. Monocultures of any crop will enrich populations of pests and diseases that may adversely affect

production. In addition to reducing selection pressure for virulence and aggressiveness, crop rotation allows time for natural enemies to destroy the pathogens of one species of crop. To be most effective, rotations should include one and preferably two unrelated crops.

Simply rotating from spring wheat to winter wheat or barley can provide significant control of some pests and diseases. Rotating to spring wheat from winter wheat helps control winter annual grass weeds that cannot be controlled by selective herbicides in winter wheat.

Rotating from spring wheat to winter wheat can, however, favor wheat streak mosaic if the green bridge (growing vegetation) is not controlled for an adequate amount of time prior to planting of winter wheat after harvest of spring wheat. Usually, the time between harvesting spring wheat and planting winter wheat is too short to control the wheat curl mite, the vector of the virus.

Legumes grown for seed or forage or as a green manure in rotation with small grains can supply part of the nitrogen for the crop and can be an important element in maintaining soil quality. When leguminous crops are killed by tillage or herbicides, the organic nitrogen formed by the roots is decomposed into inorganic forms, first ammonium and then nitrates (the primary form available to crops), by bacteria in the soil.

Alfalfa and legumes in general are an excellent source of nitrogen, but they can also be a large user of nitrogen if harvested repeatedly for hay during the season of termination. The more nitrogen hauled off the field for high-protein hay or grain the less available for the next crop. For maximum return of nitrogen from legumes, it is best to take only one or two cuttings in the year before a crop is planted. Allow legume crop to

grow good, lush growth, which is essential to nitrogen fixation, and then incorporate foliage together with the crowns and roots.

Thorough soil incorporation of legumes as green manure usually returns the largest amount of nitrogen. However, other options are; 1) mulch tillage, which leaves more legume residue on the surface, and 2) chemically killing the legume and direct seeding the next crop. These practices are important where the potential for soil erosion is high or water availability is low.

Consideration should be given to the cultural and management measures needed for crop production, good soil management, irrigation water management, soil quality, and for maximum utilization of plant available soil water.

If soil moisture is limiting crop production, consider implementing practices such as Conservation Tillage (329), Crop Residue Use (344), Herbaceous Wind Barriers (422A), and others that will hold precipitation (rain and snow) on the soil surface. Chemical or mechanical fallow should only be used when soil moisture is inadequate for the following crop or when weed infestations occur.

Where crop residues are removed or low residue crops are produced, cover crops or green manure crops may be needed for erosion control or to improve soil quality and fertility.

A designed crop rotation may be altered due to moisture conditions, weed or insect infestations, or diseases, as long as the criteria for this practice are met.

Documentation and maintaining records by field is an important part of a successful conservation crop rotation.

PLANS AND SPECIFICATIONS

Specifications for establishment and operation of this practice shall be prepared for each field or treatment unit according to the Criteria, Considerations, and Operation and Maintenance described in this standard.

Specifications shall be recorded using approved specification sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

OPERATION AND MAINTENANCE

Rotations shall provide for acceptable substitute crops in case of crop failure or shift in planting intentions for weather related or

economic reasons. Acceptable substitutes are crops having similar properties that meet the criteria for all the resource concerns identified for the field or treatment unit.

In areas where summer fallow is practiced, the decision to plant a crop or fallow shall be made annually based on soil moisture at planting time. Fields shall be fallowed only when soil moisture is not adequate to produce a crop *or when soil quality improving fallow is determined to be necessary*. If moisture supply is adequate but limited, short-season shallow rooted crops shall be selected and grown. Deep rooted crops shall follow shallow rooted crops in subsequent years, if needed, to utilize all plant available water in the root zone.

Table 1. Plant Available Water Capacities for Soil Textural Classes in Montana^{1/} and ^{2/}

		Soil Textural Class	Estimated Average Plant AWC (in/ft) ^{2/}
Sandy Soils	Course Texture	Sands	0.5
		Loamy sands	1.0
		Loamy fine sands	>
		Loamy v. fine sands	>
		Fine sands	>
		V. fine sands	>
Loamy Soils	Moderate Coarse Texture	Sandy loam	>
		Fine sandy loam	>
		V. fine sandy loam	>
	Medium Texture	Loam	>
		Silt loam	>
		Silt	>
		Clay loam	>
	Moderately Fine Texture	Sandy clay loam	>
		Silty clay loam	>
Clayey Soils	Fine Texture	Sandy clay	>
		Silty clay	>
		Clay	>

^{1/} Soluble salts and gravel will decrease plant available water capacity. Organic matter and good soil structure will increase it. Capacity increases about 0.1 in/ft for each 1% organic matter. Soils with water restricting layers like compact subsoils, shallow bedrock or stratification can increase plant available water capacity of the overlying layers. Soils that are deep, medium textured and uniform can have decreased plant available water but allow for deeper rooting.

^{2/} Approved by Soils Committee, MSU, Plant and Soil Science Planning Conference, January 31, 1984.

Table 2. Probability (%) of receiving at least the indicated amounts of growing season precipitation at 24 selected locations in Montana.

	<i>Average</i>	<i>Precipitation - Inches</i>						
	<i>Precipitation</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>
	<i>(Inches)</i>	<i>Percent</i>						
<i><u>Big Timber</u></i>								
<i>Mar 29 - Jun 27</i>	<i>6.48</i>	<i>96.3</i>	<i>94.7</i>	<i>85.3</i>	<i>75.4</i>	<i>60.3</i>	<i>32.7</i>	<i>22.4</i>
<i>Apr 12 - Jul 11</i>	<i>6.42</i>	<i>98.7</i>	<i>94.8</i>	<i>83.4</i>	<i>71.5</i>	<i>55.1</i>	<i>36.7</i>	<i>23.7</i>
<i>May 03 - Aug 01</i>	<i>6.09</i>	<i>>99.0</i>	<i>93.5</i>	<i>81.5</i>	<i>62.9</i>	<i>47.2</i>	<i>30.6</i>	<i>16.4</i>
<i><u>Bozeman</u></i>								
<i>Mar 29 - Jun 27</i>	<i>7.06</i>	<i>>99.0</i>	<i>>99.0</i>	<i>95.7</i>	<i>83.1</i>	<i>70.7</i>	<i>49.6</i>	<i>34.3</i>
<i>Apr 12 - Jul 11</i>	<i>6.93</i>	<i>>99.0</i>	<i>98.7</i>	<i>94.8</i>	<i>87.1</i>	<i>68.5</i>	<i>42.6</i>	<i>30.3</i>
<i>May 03 - Aug 01</i>	<i>6.50</i>	<i>>99.0</i>	<i>97.1</i>	<i>85.8</i>	<i>81.1</i>	<i>60.5</i>	<i>41.1</i>	<i>27.9</i>
<i><u>Cascade</u></i>								
<i>Mar 29 - Jun 27</i>	<i>6.83</i>	<i>>99.0</i>	<i>96.0</i>	<i>87.4</i>	<i>71.6</i>	<i>63.6</i>	<i>49.8</i>	<i>30.1</i>
<i>Apr 12 - Jul 11</i>	<i>7.01</i>	<i>>99.0</i>	<i>98.6</i>	<i>90.9</i>	<i>73.8</i>	<i>63.0</i>	<i>49.0</i>	<i>33.8</i>
<i>May 03 - Aug 01</i>	<i>6.59</i>	<i>>99.0</i>	<i>93.1</i>	<i>86.6</i>	<i>70.2</i>	<i>56.1</i>	<i>42.7</i>	<i>26.4</i>
<i><u>Choteau</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.60</i>	<i>98.4</i>	<i>90.2</i>	<i>74.1</i>	<i>50.2</i>	<i>34.4</i>	<i>18.2</i>	<i>14.9</i>
<i>Apr 12 - Jul 11</i>	<i>6.05</i>	<i>98.8</i>	<i>93.3</i>	<i>84.1</i>	<i>61.3</i>	<i>39.9</i>	<i>223.2</i>	<i>17.2</i>
<i>May 03 - Aug 01</i>	<i>6.23</i>	<i>97.8</i>	<i>93.7</i>	<i>80.1</i>	<i>63.6</i>	<i>41.7</i>	<i>29.7</i>	<i>22.0</i>
<i><u>Crow Agency</u></i>								
<i>Mar 29 - Jun 27</i>	<i>6.39</i>	<i>>99.0</i>	<i>95.0</i>	<i>74.9</i>	<i>63.2</i>	<i>58.3</i>	<i>39.5</i>	<i>25.1</i>
<i>Apr 12 - Jul 11</i>	<i>6.29</i>	<i>>99.0</i>	<i>97.3</i>	<i>78.3</i>	<i>68.0</i>	<i>50.8</i>	<i>33.8</i>	<i>21.1</i>
<i>May 03 - Aug 01</i>	<i>5.67</i>	<i>>99.0</i>	<i>92.7</i>	<i>73.1</i>	<i>57.1</i>	<i>42.4</i>	<i>28.5</i>	<i>15.5</i>

Table 2. Probability (%) of receiving at least the indicated amounts of growing season precipitation at 24 selected locations in Montana. (Continued)

	<i>Average Precipitation</i>	<i>Precipitation - Inches</i>						
		2	3	4	5	6	7	8
	<i>(Inches)</i>	<i>Percent</i>						
<u><i>Cut Bank</i></u>								
<i>Mar 29 - Jun 27</i>	<i>5.27</i>	<i>95.9</i>	<i>93.4</i>	<i>80.9</i>	<i>56.6</i>	<i>27.4</i>	<i>12.4</i>	<i>9.8</i>
<i>Apr 12 - Jul 11</i>	<i>5.76</i>	<i>98.3</i>	<i>93.9</i>	<i>81.6</i>	<i>63.6</i>	<i>40.9</i>	<i>21.5</i>	<i>13.0</i>
<i>May 03 - Aug 01</i>	<i>5.85</i>	<i>98.6</i>	<i>92.4</i>	<i>77.1</i>	<i>64.7</i>	<i>47.1</i>	<i>25.5</i>	<i>12.9</i>
<u><i>Ekalaka</i></u>								
<i>Mar 29 - Jun 27</i>	<i>6.77</i>	<i>98.1</i>	<i>94.1</i>	<i>87.0</i>	<i>77.8</i>	<i>58.2</i>	<i>46.0</i>	<i>27.2</i>
<i>Apr 12 - Jul 11</i>	<i>7.26</i>	<i>>99.0</i>	<i>94.4</i>	<i>91.3</i>	<i>81.7</i>	<i>70.8</i>	<i>54.1</i>	<i>40.0</i>
<i>May 03 - Aug 01</i>	<i>7.31</i>	<i>97.9</i>	<i>96.6</i>	<i>90.7</i>	<i>82.4</i>	<i>71.3</i>	<i>60.0</i>	<i>38.6</i>
<u><i>Flatwillow</i></u>								
<i>Mar 29 - Jun 27</i>	<i>6.04</i>	<i>98.8</i>	<i>96.4</i>	<i>78.8</i>	<i>63.0</i>	<i>48.2</i>	<i>30.7</i>	<i>28.3</i>
<i>Apr 12 - Jul 11</i>	<i>6.38</i>	<i>>99.0</i>	<i>97.9</i>	<i>85.8</i>	<i>69.1</i>	<i>53.6</i>	<i>37.8</i>	<i>25.2</i>
<i>May 03 - Aug 01</i>	<i>6.49</i>	<i>>99.0</i>	<i>95.0</i>	<i>85.2</i>	<i>77.4</i>	<i>51.9</i>	<i>35.5</i>	<i>25.4</i>
<u><i>Forks</i></u>								
<i>Mar 29 - Jun 27</i>	<i>5.33</i>	<i>97.9</i>	<i>88.1</i>	<i>67.9</i>	<i>50.7</i>	<i>36.4</i>	<i>20.5</i>	<i>12.8</i>
<i>Apr 12 - Jul 11</i>	<i>6.06</i>	<i>>99.0</i>	<i>93.0</i>	<i>77.9</i>	<i>64.0</i>	<i>51.0</i>	<i>35.2</i>	<i>22.6</i>
<i>May 03 - Aug 01</i>	<i>6.21</i>	<i>>96.7</i>	<i>91.5</i>	<i>81.0</i>	<i>65.3</i>	<i>43.4</i>	<i>36.2</i>	<i>28.8</i>
<u><i>Fort Benton</i></u>								
<i>Mar 29 - Jun 27</i>	<i>6.67</i>	<i>>99.0</i>	<i>>99.0</i>	<i>89.5</i>	<i>76.3</i>	<i>57.9</i>	<i>39.5</i>	<i>21.1</i>
<i>May 01 - Jul 31</i>	<i>6.68</i>	<i>>99.0</i>	<i>97.4</i>	<i>86.8</i>	<i>81.6</i>	<i>57.9</i>	<i>39.5</i>	<i>23.7</i>

Table 2. Probability (%) of receiving at least the indicated amounts of growing season precipitation at 24 selected locations in Montana. (Continued)

	<i>Average Precipitation</i>	<i>Precipitation - Inches</i>						
		2	3	4	5	6	7	8
	<i>(Inches)</i>	<i>Percent</i>						
<u><i>Glasgow</i></u>								
<i>Mar 29 - Jun 27</i>	<i>5.19</i>	<i>>99.0</i>	<i>83.2</i>	<i>69.6</i>	<i>48.3</i>	<i>33.5</i>	<i>20.7</i>	<i>13.4</i>
<i>Apr 12 - Jul 11</i>	<i>5.78</i>	<i>>99.0</i>	<i>87.8</i>	<i>77.7</i>	<i>61.6</i>	<i>37.4</i>	<i>33.3</i>	<i>19.3</i>
<i>May 03 - Aug 01</i>	<i>5.84</i>	<i>>99.0</i>	<i>90.7</i>	<i>77.5</i>	<i>55.7</i>	<i>46.4</i>	<i>29.5</i>	<i>21.7</i>
<u><i>Glendive</i></u>								
<i>Mar 29 - Jun 27</i>	<i>6.20</i>	<i>98.4</i>	<i>90.3</i>	<i>84.9</i>	<i>66.8</i>	<i>60.6</i>	<i>33.7</i>	<i>25.7</i>
<i>Apr 12 - Jul 11</i>	<i>6.78</i>	<i>98.8</i>	<i>93.7</i>	<i>88.2</i>	<i>75.4</i>	<i>70.1</i>	<i>52.3</i>	<i>27.2</i>
<i>May 03 - Aug 01</i>	<i>6.87</i>	<i>97.8</i>	<i>96.9</i>	<i>90.9</i>	<i>77.7</i>	<i>63.0</i>	<i>49.1</i>	<i>30.6</i>
<u><i>Great Falls</i></u>								
<i>Mar 29 - Jun 27</i>	<i>6.15</i>	<i>>99.0</i>	<i>98.1</i>	<i>88.5</i>	<i>63.9</i>	<i>39.3</i>	<i>29.2</i>	<i>20.3</i>
<i>Apr 12 - Jul 11</i>	<i>6.44</i>	<i>>99.0</i>	<i>97.3</i>	<i>88.5</i>	<i>69.2</i>	<i>44.8</i>	<i>38.9</i>	<i>22.4</i>
<i>May 03 - Aug 01</i>	<i>6.25</i>	<i>>99.0</i>	<i>95.1</i>	<i>80.8</i>	<i>66.0</i>	<i>49.9</i>	<i>35.4</i>	<i>22.9</i>
<u><i>Havre</i></u>								
<i>Mar 29 - Jun 27</i>	<i>4.95</i>	<i>98.9</i>	<i>84.8</i>	<i>63.9</i>	<i>48.0</i>	<i>30.0</i>	<i>17.6</i>	<i>8.0</i>
<i>Apr 12 - Jul 11</i>	<i>5.33</i>	<i>>99.0</i>	<i>93.8</i>	<i>73.2</i>	<i>52.4</i>	<i>31.3</i>	<i>24.5</i>	<i>13.9</i>
<i>May 03 - Aug 01</i>	<i>5.43</i>	<i>98.3</i>	<i>89.4</i>	<i>73.0</i>	<i>52.4</i>	<i>36.1</i>	<i>20.9</i>	<i>13.0</i>
<u><i>Hamilton</i></u>								
<i>Mar 29 - Jun 27</i>	<i>3.94</i>	<i>96.0</i>	<i>71.7</i>	<i>48.7</i>	<i>27.1</i>	<i>15.8</i>	<i>7.7</i>	<i>3.8</i>
<i>Apr 12 - Jul 11</i>	<i>4.12</i>	<i>94.1</i>	<i>73.4</i>	<i>57.9</i>	<i>31.2</i>	<i>20.0</i>	<i>12.2</i>	<i>4.8</i>
<i>May 03 - Aug 01</i>	<i>4.03</i>	<i>91.0</i>	<i>71.6</i>	<i>50.3</i>	<i>32.4</i>	<i>17.5</i>	<i>6.6</i>	<i>4.1</i>

Table 2. Probability (%) of receiving at least the indicated amounts of growing season precipitation at 24 selected locations in Montana. (Continued)

	<i>Average Precipitation</i>	<i>Precipitation - Inches</i>						
		2	3	4	5	6	7	8
	<i>(Inches)</i>	<i>Percent</i>						
<i><u>Helena</u></i>								
<i>Mar 29 - Jun 27</i>	<i>4.66</i>	<i>98.3</i>	<i>83.2</i>	<i>68.0</i>	<i>40.4</i>	<i>29.0</i>	<i>12.3</i>	<i>3.9</i>
<i>Apr 12 - Jul 11</i>	<i>4.24</i>	<i>>99.0</i>	<i>90.6</i>	<i>71.8</i>	<i>44.1</i>	<i>28.6</i>	<i>16.2</i>	<i>6.6</i>
<i>May 03 - Aug 01</i>	<i>4.78</i>	<i>>98.6</i>	<i>87.3</i>	<i>71.1</i>	<i>40.3</i>	<i>23.5</i>	<i>11.9</i>	<i>5.8</i>
<i><u>Huntley</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.70</i>	<i>96.6</i>	<i>94.4</i>	<i>70.0</i>	<i>58.4</i>	<i>43.7</i>	<i>27.7</i>	<i>17.2</i>
<i>Apr 12 - Jul 11</i>	<i>5.77</i>	<i>96.2</i>	<i>94.0</i>	<i>80.7</i>	<i>60.4</i>	<i>46.5</i>	<i>29.9</i>	<i>22.3</i>
<i>May 03 - Aug 01</i>	<i>5.38</i>	<i>97.1</i>	<i>85.2</i>	<i>76.2</i>	<i>57.1</i>	<i>45.9</i>	<i>22.8</i>	<i>16.2</i>
<i><u>Jordan</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.10</i>	<i>92.7</i>	<i>79.4</i>	<i>62.6</i>	<i>50.1</i>	<i>37.4</i>	<i>21.6</i>	<i>14.2</i>
<i>Apr 12 - Jul 11</i>	<i>5.68</i>	<i>95.5</i>	<i>82.2</i>	<i>68.2</i>	<i>56.0</i>	<i>43.7</i>	<i>31.6</i>	<i>20.7</i>
<i>May 03 - Aug 01</i>	<i>5.56</i>	<i>97.2</i>	<i>88.7</i>	<i>68.3</i>	<i>55.7</i>	<i>46.9</i>	<i>22.0</i>	<i>18.3</i>
<i><u>Kalispell</u></i>								
<i>Mar 29 - Jun 27</i>	<i>4.80</i>	<i>100</i>	<i>95.7</i>	<i>73.5</i>	<i>46.0</i>	<i>16.7</i>	<i>7.3</i>	<i>6.3</i>
<i>Apr 12 - Jul 11</i>	<i>5.12</i>	<i>100</i>	<i>97.7</i>	<i>75.9</i>	<i>51.7</i>	<i>24.5</i>	<i>9.4</i>	<i>6.7</i>
<i>May 03 - Aug 01</i>	<i>4.45</i>	<i>100</i>	<i>95.3</i>	<i>71.4</i>	<i>40.4</i>	<i>18.7</i>	<i>7.4</i>	<i>6.7</i>
<i><u>Malta</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.42</i>	<i>98.2</i>	<i>83.1</i>	<i>71.8</i>	<i>54.0</i>	<i>35.0</i>	<i>25.3</i>	<i>16.3</i>
<i>Apr 12 - Jul 11</i>	<i>5.97</i>	<i>98.4</i>	<i>90.7</i>	<i>78.1</i>	<i>62.2</i>	<i>43.6</i>	<i>28.7</i>	<i>21.4</i>
<i>May 03 - Aug 01</i>	<i>6.19</i>	<i>97.0</i>	<i>90.5</i>	<i>82.3</i>	<i>63.0</i>	<i>49.4</i>	<i>32.7</i>	<i>19.9</i>

Table 2. Probability (%) of receiving at least the indicated amounts of growing season precipitation at 24 selected locations in Montana. (Continued)

	<i>Average Precipitation</i>	<i>Precipitation - Inches</i>						
		2	3	4	5	6	7	8
	<i>(Inches)</i>	<i>Percent</i>						
<i><u>Medicine Lake</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.74</i>	<i>96.5</i>	<i>86.5</i>	<i>69.0</i>	<i>56.9</i>	<i>46.9</i>	<i>26.5</i>	<i>21.8</i>
<i>Apr 12 - Jul 11</i>	<i>6.62</i>	<i>>99.0</i>	<i>92.5</i>	<i>77.5</i>	<i>69.7</i>	<i>60.9</i>	<i>39.0</i>	<i>24.3</i>
<i>May 03 - Aug 01</i>	<i>7.02</i>	<i>>99.0</i>	<i>97.8</i>	<i>84.8</i>	<i>79.2</i>	<i>62.4</i>	<i>38.5</i>	<i>34.3</i>
<i><u>Mildred</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.84</i>	<i>95.9</i>	<i>90.8</i>	<i>76.7</i>	<i>64.6</i>	<i>46.9</i>	<i>32.2</i>	<i>18.1</i>
<i>Apr 12 - Jul 11</i>	<i>6.29</i>	<i>98.4</i>	<i>94.7</i>	<i>80.5</i>	<i>70.6</i>	<i>59.1</i>	<i>37.7</i>	<i>24.2</i>
<i>May 03 - Aug 01</i>	<i>6.23</i>	<i>98.6</i>	<i>93.7</i>	<i>82.7</i>	<i>69.4</i>	<i>56.8</i>	<i>35.3</i>	<i>19.2</i>
<i><u>Miles City</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.74</i>	<i>97.2</i>	<i>92.9</i>	<i>71.3</i>	<i>60.9</i>	<i>45.3</i>	<i>29.3</i>	<i>17.5</i>
<i>Apr 12 - Jul 11</i>	<i>6.06</i>	<i>98.4</i>	<i>93.4</i>	<i>78.7</i>	<i>64.3</i>	<i>49.1</i>	<i>30.7</i>	<i>22.3</i>
<i>May 03 - Aug 01</i>	<i>6.01</i>	<i>>99.0</i>	<i>89.7</i>	<i>79.3</i>	<i>64.8</i>	<i>48.0</i>	<i>32.3</i>	<i>19.3</i>
<i><u>Moccasin</u></i>								
<i>Mar 29 - Jun 27</i>	<i>6.68</i>	<i>>99.0</i>	<i>97.2</i>	<i>92.4</i>	<i>78.8</i>	<i>58.4</i>	<i>44.5</i>	<i>31.7</i>
<i>Apr 12 - Jul 11</i>	<i>7.11</i>	<i>>99.0</i>	<i>96.7</i>	<i>92.9</i>	<i>81.7</i>	<i>67.0</i>	<i>53.8</i>	<i>41.1</i>
<i>May 03 - Aug 01</i>	<i>7.28</i>	<i>>99.0</i>	<i>98.8</i>	<i>94.5</i>	<i>84.4</i>	<i>68.4</i>	<i>58.9</i>	<i>38.1</i>
<i><u>Plevna</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.99</i>	<i>98.8</i>	<i>91.8</i>	<i>77.0</i>	<i>65.3</i>	<i>52.4</i>	<i>39.6</i>	<i>21.6</i>
<i>Apr 12 - Jul 11</i>	<i>6.42</i>	<i>>99.0</i>	<i>89.7</i>	<i>81.5</i>	<i>69.9</i>	<i>59.7</i>	<i>47.7</i>	<i>27.6</i>
<i>May 03 - Aug 01</i>	<i>6.52</i>	<i>>99.0</i>	<i>95.4</i>	<i>85.3</i>	<i>70.9</i>	<i>62.2</i>	<i>49.7</i>	<i>23.8</i>

Table 2. Probability (%) of receiving at least the indicated amounts of growing season precipitation at 24 selected locations in Montana. (Continued)

	<i>Average</i>	<i>Precipitation - Inches</i>						
	<i>Precipitation</i>	2	3	4	5	6	7	8
	<i>(Inches)</i>	<i>Percent</i>						
<i><u>Poplar</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.52</i>	<i>97.1</i>	<i>87.8</i>	<i>72.8</i>	<i>62.4</i>	<i>40.1</i>	<i>24.6</i>	<i>14.0</i>
<i>Apr 12 - Jul 11</i>	<i>6.49</i>	<i>98.6</i>	<i>91.3</i>	<i>79.7</i>	<i>70.1</i>	<i>60.8</i>	<i>42.4</i>	<i>29.2</i>
<i>May 03 - Aug 01</i>	<i>6.83</i>	<i>>99.0</i>	<i>95.2</i>	<i>84.9</i>	<i>69.1</i>	<i>55.2</i>	<i>44.4</i>	<i>39.3</i>
<i><u>St. Ignatius</u></i>								
<i>Mar 29 - Jun 27</i>	<i>5.73</i>	<i>100</i>	<i>96.2</i>	<i>89.7</i>	<i>72.6</i>	<i>41.8</i>	<i>32.6</i>	<i>14.3</i>
<i>Apr 12 - Jul 11</i>	<i>5.95</i>	<i>100</i>	<i>100</i>	<i>89.2</i>	<i>72.9</i>	<i>45.9</i>	<i>27.3</i>	<i>22.9</i>
<i>May 03 - Aug 01</i>	<i>5.11</i>	<i>100</i>	<i>100</i>	<i>89.4</i>	<i>55.2</i>	<i>30.3</i>	<i>21.5</i>	<i>15.6</i>

Table 3. Potential Indicators of Soil Quality

<i>Biological</i>	<i>Chemical</i>	<i>Physical</i>
	<i><u>Field, farm, or watershed indicators</u></i>	
<i>Crop yield</i>	<i>Changing quality/quantity of OM</i>	<i>Topsoil thickness</i>
<i>Crop appearance</i>	<i>pH changes</i>	<i>Soil color</i>
<i>Weed pressure</i>	<i>Available P and K changes</i>	<i>Subsoil exposure</i>
<i>Nutrient deficiencies</i>	<i>Change in cation levels</i>	<i>Compaction</i>
<i>Earthworms</i>	<i>Change in N availability</i>	<i>Crusting</i>
<i>Root growth patterns</i>	<i>Change in heavy metals</i>	<i>Infiltration</i>
<i>Biomass production</i>	<i>Change in salinity</i>	<i>Runoff</i>
<i>Canopy cover</i>	<i>Nutrient loss to streams and groundwater</i>	<i>Sediment fans</i>
	<i>Pesticide loss to streams and groundwater</i>	<i>Surface cover</i>
		<i>Rill or gully erosion</i>
		<i>Plant emergence</i>
		<i>Ease of tillage</i>
		<i>Soil Structure</i>

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